**Cairo University**
**Faculty of Archaeology**
**Conservation Department**

# Study For Treatments the Effect of the Microbiological Deterioration of Mural Painting Executed by Tempra Technique, Applied on Selected Models

A Thesis
Presented For the Fulfillment of Master Degree on Restoration & Conservation of Antiquities

**Submitted by**

**Abeer Fouad Abdel Moiez Abdel Moniem**
Demonstrator – Cons. Dep., Faculty of Archaeology,
Fayoum University

**Supervised by**

**Prof. Dr. Fatma Mohamed Helmi**
Prof. of Study of archaeological materials and their conservation, Previous head of Cons. Dep., & Director of Cons. Center of Arch., Manuscripts & Museum objects
Faculty of Archaeology, Cairo University

**Prof. Dr. Mohamed Abdel Maksoud Rizk**
Prof. in Microbiology, Botany Dep., Faculty of Science , Cairo University

**ASS. Prof. Hemdan Rabia Attaia**
Assistant prof. Conservation. Dep., and Vice Dean for Society and Environment , Faculty of Archaeology , Fayoum University

2010

# Summary

**The study is divided in to five chapters as follow**

## Chapter I: Topographic Study of the Selected Archaeological Sites and the Structure of their Mural Paintings

This chapter focuses on the scientific concept of topography and how to use it in restoration. Also it studies the topography of the Giza Plateau and Saqqara tombs that is because the tombs of the case study located in these regions.

The study shows that the Giza Plateau is located in an area of a high Nummilitic limestone and the planning of the cemetery is based mainly on three pyramids, especially the great pyramid, and the cemetery of Saqqara is an unhigh land, but the Plateau appeared relatively high when compared to the valley of the Nile with height of 35m.

In addition of studying the physical structure of wall paintings, especially the murals executed by Tempra technique because the tombs in the case study done by Tempra technique, so the research studies this technique and how to apply it, beside that, it studies the plaster, pigments, and the media which used in murals.

### Chapter II: Study of scientific methods for the recording, examination and analysis of murals paintings

This chapter studies the best methods used in the recording, examination and analysis of wall paintings. The most used recording in archaeological field are methods of documentation contain archaeological, architectural and photographic recording.

Furthermore the chapter shows the use of the visual examination methods and investigation devices, such as the use of Optical Microscope, Polarized Microscope and Scanning Electron Microscope which help in identifying the manifestations of damage caused by the deterioration factors. Beside that the chapter studies Infrared and Ultraviolet photography, which helps in identifying the under laying, furthermore the

chapter shows analysis methods which help to understanding the murals, as using X-ray diffraction, which is considered as one of the most analysis types, in addition to the use of infrared analysis and gas chromatography in the identification of media.

## Chapter III: Microorganisms, their destructive impact on the murals and the methods of treatments

This chapter is divided into two main points, First; the study of microorganisms' impacting murals like Bacteria, Actinomycetes, Fungi, and Lichens and their ways of life, growth, nutrition and their destructive impact on the murals, while the other is to study the methods of treatment used to protect murals from these microorganisms attack.

The chapter studies the bacteria, its forms, sizes, and cell structure in addition to its deteriorating effect on murals specially the genus *Thiobacillus ferrooxidans* which causing oxidation of iron in stone and pigments, And the *Nitrobacter* and *Nitrosomanas* producting nitric acid, which reacts with the calcium component of soluble calcium nitrate. Also the *cyanobacteria* which can product a biofilm on the surface, this biofilm can attract other organisms to attack the murals.

In addition the chapter presents the actinomycetes their structure cell, life cycle and their deterioration on the mural paintings.

Furthermore it studies the fungi life, ways of nutrition and destructive impact on murals especially fungi of the genus *Aspergillus niger*, *Aspergillus flavus*, *Penicillium sp*., *Cladosporium* & *Alternaria.*

There are various ways to damage the wall paintings by fungi as they produce pigments of different colors on the surfaces of wall painting, also when they grow the hyphea penetrate the murals and cause many micro cracks.

Beside that the chapter studies the lichens their structural cells, quality of life and their types which presented on surfaces of wall paintings in addition of studying their damage by mechanical hyphae and chemical secretion by metabolic Products.

The microbial treatments have been divided according to the study as follow: mechanical methods by scalpels and brushes and their advantages and disadvantages of these methods, chemical methods through the use of

various types of biocides and extent of the advantages and disadvantages of these methods, and the use of bleach, which works to remove fungal and microbial stains, The study also considered the use of biological processes by the use of *Trichoderma* Bio calcifying Bacteria (BCB) and disadvantages of this method.

Finally, the chapter discussed the using of the most modern methods of treatment for the first time, by electromagnetic low frequency waves according to the theory of Metabolic Biomagnetic Resonance Model and this kind of treatment working for control the growth by electromagnetic signal which compatible with the frequency of the physiological process to be discouraged, Every physiological process has a different frequency when it works which means that if the frequency is known, it can be controlled simply by sending the same frequency to the cell. This new frequency can overlap with main frequency of the physiological process and that will completely stop the process because the algebraic sum of the reference cell frequency and the transmitted frequency is equal to zero, so the physiological process stops.

## Chapter IV: Experimental study for the treatment of some mural paintings destroyed by microorganisms in the selected tombs

**This chapter is based on three parts, namely:**

- **Part I**: This includes the isolation of microorganisms: fungi, bacteria and actinomycetes form the surface of murals in each of the tomb of Nefer bou Ptah and Emrry in Giza and Hor moheb in Saqqara, to identify the most microorganisms destroyed the tombs. So, the organisms isolated from murals, air and dust of the three floors were identified by using the scientific keys allocated to it.

- **Point II**: This includes the use of physical methods through the use of ionizing radiation by gamma Produced by Cesium 137 $Cs^{137}$ and its role for inhibiting the growth of both *Aspergillus niger* and *Aspergillus flavus*, and discouraging the growth of bacteria of the genus *Hallobacteria* and *Micrococcus ceneries*, beside to Actinomycetes of the genus *Streptomyces albus* as one of the most widespread microbes in the studied tombs. Then exposed these micro-organisms were to irradiation by different doses of Gamma rays until reach the lethal dose when killed the microbes.

Also the study used the most modern technique for the first time in archaeological field in general and wall paintings in particular which is electromagnetic waves, these waves can communicate with the signal of the growth process and overlap with it to stop the process by changing the DNA of the cell membrane and in both cases it completely stopped the process.

- **Point III**: This point includes the use of antibiotic extract from a *Trichoderma* fungus which has the ability to control *Aspergillus niger* and *Aspergillus flavus*, which consider to be the most fungi attacking the wall paintings, and to clean their metabolic secretions which attacking the murals surface. This antibiotic gives effective results up to 100% without changing the impact of the Murals or color tones of their pigments.

## Chapter V: Applied Study of the treatment of microbiological damage in Nefer bou ptah tomb in Giza Plateau.

This chapter explains the applied study on the selected tombs Nefer bou Petah tomb in Giza Plateau, the study begins by recording and documendating of the tomb, studying of climate over the full year 2008-2009 within and outside the tomb, and studying of the building materials, forming the wall paintings from the support, ground layer and the paint layer by using X-ray diffraction and Polarizing Microscope, Scanning Electron Microscope equipped with EDX unit, in addition of using FTIR to study the medium.

X- ray diffraction analysis shows that the support is a Dolomitic Limestone and the plaster is composed of Calcite by about 44%, Anhydrite by about 33 %, Gypsum by about 14% and traces of Quartz by about 7%, with respect to pigments of the wall paintings it shows the using of Goethite as a yellow pigment, Hematite as red pigment, and Malachite as green one, FTIR analysis shows that the medium is egg yolk.

More over the research the microbial deterioration of the mural paintings and its treatment by both mechanical and chemical methods, in Nefer bau btah tomb the antibiotic **6 penthyl α pyrone phenol,** which proved success in the experimental study in chapter IV. It was used by applying on the mural surface and covered with a layer of gauze to provide a

relative rate of moisture sufficient to achieve the highest success rates of the antibiotic. This antibiotic gave the perfect result in the removal of microbial deterioration without causing any damage. The final process was sterilizing the entire tomb to ensure the elimination of any Microbes in the air to get rid of the source of microbial deterioration again.

At the end the whole tomb was sterilized by UV for 144h which gives the best results in sterilization, also the ground was sterilized by Isopropyl alcohol, which is the most common alcohols used for sterilization.